A STUDY OF SUCCESS FACTORS IN FIRST YEAR ALGEBRA

by

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A. B., University of Kansas, 1918.

Submitted to the Department of Education and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

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July, 1927.

ACKNOWLEDGMENTS

To the Department of Educational Research of the Kansas City, Missouri Schools for supplying the tests and part of the data used in this study.

To the Mathematics teachers of Central Junior High School for their cooperation in giving tests.

To Professor Paul A. Witty, adviser in the writing of this thesis.

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A STUDY OF SUCCESS FACTORS IN FIRST YEAR ALGEBRA.

CHAPTER I

INTRODUCTION

Modern demands upon the Junior High School are forcing educators to a further consideration of the child and the curriculum. As a result, there have been many changes in methods of classification and many improvements have been made in methods of teaching. This is especially true in the field of mathematics. Dr. David Eugene Smith,[1] one of the leading mathematicians in the United States, gives "the rise of the Junior High Schools" as one of "the most potent of the later influences for betterment" in the teaching of mathematics. The writer of this thesis had the above facts in mind while conducting this investigation of success factors in first year algebra.

Mental age, reading age, arithmetic reasoning ability, and ability in computation were measured. Then these factors were studied to find their relationship to success in algebra. For this investigation the National Intelligence Test was used to measure mental age. Reading age was measured by the Thorndike-McCall Reading Scale. The Stevenson Problem Analysis Test determined arithmetic reasoning ability. The Courtis Standard Research Tests

1. National Council of Teachers of Mathematics. (First Year Book.)

in addition, subtraction, multiplication, and addition decided ability in computation.

The object of the investigation was to disclose the relationship of mental age, reading age, arithmetic reasoning ability, and ability in computation with success in algebra as a problem of classification and of success in algebra.

CHAPTER II

RELATED STUDIES

An experiment was carried on during the years 1921-1923 by Mr. C. M. Austin in the High School at Oak Park, Illinois.[1] He says, "Two purposes were in view - first, to see if some relation between general intelligence as revealed by the Otis Test and school grades in algebra could be discovered; and second, to see if this test would give a sound basis for classifying pupils for the study of algebra and other school subjects.

In February 1921, the Otis Test was given to two hundred entering freshmen. These scores with the algebra grades given at the end of the semester show a positive correlation of $0.54 \pm .03$. Forty pupils failed to secure a passing grade at the end of the semester. Of those failing, 22 were above normal and 18 below. The number of failures corresponds closely to the number of those who are indicated by the test as being below normal in intelligence. Thirty-eight were below normal of whom 20 passed and 18 failed.

In October 1921, the Otis Test was given to 395 entering pupils. The same correlation as above was computed and he found the correlation $.54 \pm .03$. Of the thirty-eight below normal, twenty passed and eighteen failed. Of the forty who failed, 22 were above normal, eighteen below.

1. Mathematics Teacher, January, 1924.

In February 1922, the Otis Test was given to 176 pupils. These results gave a correlation of 0.54±4. Of the 35 below normal, 15 passed, 20 failed. Of the 34 who failed, 15 were above normal, 19 below.

In September 1922, 335 pupils were tested and the correlation was found to be 0.40 ± .03. Of the 85 below normal, 54 passed, 31 failed. Of the 65 who failed, 34 were above normal, 31 below.

In February 1923, 205 pupils were tested and the correlation was found to be 0.53 ± .03. Of the 35 below normal, 12 passed, 23 failed. Of the 44 who failed, 21 were above normal, 23 below.

The class that entered school in September 1923 also took the test. There ware 377 pupils. Their November grades in algebra were correlated with the Otis scores. This resulted in r = 0.46 ± .03. Of the 110 below normal, 59 passed, 51 failed. Of the 51 who failed, 20 were above normal, 31 below."

From Mr. Austin's observations and the measured results of this experiment he drew the following conclusions:

"Many pupils with high Otis I. B's made low grades in algebra, no pupil with a low I. B. succeeded in making a high grade in algebra.

The Otis Test is not an infallible guide in classifying pupils for achievement in algebra. It can select those who are capable mentally of succeeding but it cannot measure the personal

characteristics so necessary to success.

Any pupil having an I. B. of 100 or more may be sure of a passing grade in algebra if he is willing to assume the proper attitude and put forth the proper effort, since practically all the teachers testify that attitude and effort are usually the controlling factors in a pupil's success.

Correlation according to Rugg's scale is markedly present. This means that pupils with a high Otis I. B. will most likely be able to make a high grade in algebra. Since the number of cases is large and the probable error is very small the coefficient is fairly reliable."

Mr. Edwin W. Schreiber, Head of the Mathematics Department of Proviso Township High School, Maywood, Illinois[1] made a study of some of the factors of success in first year algebra. He gave standardized tests to 160 pupils in eight different classes of first year algebra. The tests were given at the time of the regular class periods during the last two weeks of school, May 27 to June 4, 1924. Of the 160 tested, 63 were girls and 97 were boys.

The following tests were given: Courtis Research Test in Addition, Series B, Form 2; Courtis Research Test in Multiplication, Series B, Form 2; Hotz First Year Algebra Scale in Problems, Series B; Hotz First Year Algebra Scale in Equation

1. Mathematics Teacher, February and March, 1925.

and Formula, Series B; Otis Self-Administering Test of Mental Ability, Higher Examination, Form A. Ability to succeed in first year algebra was measured by the semester mark received in the course.

"All the coefficients of correlation of the zero order were computed by the Pearson Product-Moment formula and those of the first order by the standard formula as given by Yule."

The following tables are found in this study.

CORRELATION BETWEEN ABILITY TO ADD AND OTHER ABILITIES.

Subjects	Correlation	P.E.	Partial Corr. Intell. Constant	P.E.
Add - Multiply	.646	.03	.615	.03
Add - Equations	.430	.04	.305	.05
Add - Problems	.316	.05	.155	.05
Add - I.Q.	.342	.05		
Add - Semester Mark	.453	.04	.342	.05

CORRELATION BETWEEN ABILITY TO MULTIPLY AND OTHER ABILITIES.

SUBJECTS	Correlation	P.E.	Partial Corr. Intell. Constant	P. E.
Multiply - Add	.646	.03	.615	.03
Multiply - Equations	.363	.05	.274	.05
Multiply - Problems	.251	.05	.131	.05
Multiply - I.Q.	.256	.05		
Multiply - Semester Mark	.488	.04	.430	.04

CORRELATION OF ABILITY TO SOLVE EQUATIONS AND FORMULAE WITH OTHER ABILITIES.

Subjects	Correlation	P.E.	Partial Corr. Intell. Constant	P.E.
Equation - Add	.430	.04	.305	.05
Equation - Multiply	.363	.05	.274	.05
Equation - Problems	.592	.03	.393	.05
Equation - I.Q.	.571	.04		
Equation - Semester Mark	.727	.03	.613	.03

CORRELATION OF ABILITY TO DERIVE EQUATIONS WITH OTHER ABILITIES

Subjects	Correlation	P.E.	Partial Corr. Intell. Constant	P.E.
Problems - Add	.316	.05	.155	.05
Problems - Multiply	.251	.05	.131	.05
Problems - Equations	.592	.03	.393	.05
Problems - I.Q.	.576	.04		
Problems - Semester Mark	.644	.03	.491	.04

CORRELATION OF GENERAL INTELLIGENCE WITH VARIOUS ABILITIES

Subjects	Correlation	P.E.
I.Q. - Add	.342	.05
I. Q. - Multiply	.256	.05
I. Q. - Equations	.571	.04
I. Q. - Problems	.576	.04
I. Q. - Semester Mark	.524	.04
Otis Rights- Semester Mark	.540	.04

He drew the following conclusions: "The two most used arithmetic abilities - addition and multiplication - have relatively little to do with a pupil's algebraic abilities, or with his success in algebra as measured by semester marks, especially is this true when the intelligence factor is a constant. Coefficients of correlation range from .13 to .30.

General intelligence is a substantial factor of success in first year algebra as the correlation of .52 indicated (Otis-Semester Mark).

In general, an I. Q. of 90, as measured by the Otis Higher Examination Form A, is necessary to pass the course in first year algebra. A score of 45, or an I. Q. of 110 predicts average success in algebra, other things being equal.

Arithmetical errors make up a very small part of the total errors made in solving problems in algebra. Here again, arithmetic and algebra, as far as errors are concerned, have little in common.

The analysis of errors in deriving equations confirms the conclusions that success in this ability is due in considerable measure to general intelligence. In fact, intelligence plays as large a role as the ability to manipulate the machinery of algebra.

In general, pupils who fail in first year algebra are much below standard both in arithmetic and algebraic abilities. The

fact that they are inferior in arithmetic abilities no doubt has a detrimental effect upon their attitude toward algebra and thus they make an inferior attempt at acquiring algebraic abilities. Pupils fail in first year algebra because of low intelligence but other causes contribute much to the millstone of failure."

F. S. Breed and E. R. Breslich of the University of Chicago[1] made a study of the value of intelligence tests in the classification of pupils.

"The tests selected for use were the Chicago Group Intelligence Test, Form A; the Otis Group Intelligence Test, Advanced Examination, Form A; and the Terman Group Test of Mental Ability, Form A. Along with the intelligence tests given at the beginning of the semester, the Cleveland Survey Arithmetic Tests were given to determine the computational skill of the pupils. The arithmetical reasoning tests administered as parts of the Otis and Terman group tests of intelligence were also used to measure ability in arithmetical reasoning. The average score in the two reasoning tests was taken to represent arithmetical reasoning ability. A score in arithmetical ability was obtained by averaging the scores in computation and reasoning with equal weight after each series had been transmuted into units on a percentile scale. At the end of a semester a third check on mathematical achievement was secured.

1. School Review, January and March, 1922.

A test was given which was composed of examples taken from the Hotz First Year Algebra Scales. These tests were given to sixty pupils in the University High School.

The following results of simple correlations were found.

Intelligence composite -	Hotz Examples	0.56 ± .06
Arithmetical Ability -	Hotz Examples	0.43 ± .08
Arithmetical Ability and Intelligence -	Hotz Examples	0.58 ± .06

They found that the pupil displacement for the ninth grade, when divided into three classes, was 51%. This resulted when arithmetical ability and intelligence composite were used as a basis for classification.

Other conclusions that they reached were these: "The Otis Test classified the pupils more satisfactorily than arithmetical ability scores, and as satisfactorily as either the intelligence composite or a combination of the intelligence-composite and arithmetical-ability scores.

Neither the composite intelligence scores nor the best of the intelligence tests provided a reliable basis for permanent classification. The error was in no case less than 50 per cent for a three sectional classification in the ninth grade.

When the Hotz examples were used as the criterion of educational achievement, the Otis test provided a basis as satisfactory for a temporary classification as any other test

or combination of tests tried, and did this more economically.

Intelligence is only one of a number of important factors in educational achievement."

In January 1920, Monroe[1] gave a selected group of pupils of the Champaign High School, the Otis Group Intelligence Scale and the Rogers Mathematical Tests. "This group of pupils had studied mathematics in high school for one semester or more. When the tests were given at the close of the first semester they were considered to be failing in mathematics.

From the results secured simple correlations were computed between the total Otis scores and those on each of the Rogers tests. They are as follows:

Otis with Rogers Algebraic Computation	$r = .37 \pm .10$
Otis with Rogers Geometry	$r = .17 \pm .12$
Otis with Rogers Interpolation	$r = .58 \pm .08$
Otis with Rogers Superposition	$r = .02 \pm .12$
Otis with Rogers Mixed Relations	$r = .47 \pm .09$
Otis with Trabue Language, L & M	$r = .52 \pm .09$

The 39 pupils (5 freshmen, 21 sophomores, 11 juniors, 2 seniors) who took both tests were slightly above the average in general intelligence.

To obtain the general Rogers score, scores in the various Rogers tests taken by each pupil were weighted and averaged.

1. Journal of Educational Research. Vol. 2, No. 4, pp. 774-776.

For this composite Rogers score and the Otis point score, $r = .41 \pm 09$.

The magnitute of this coefficient of correlation together with the fact that practically none of these pupils are carrying work in mathematics successfully, indicates that the failure to do successfully secondary mathematics depends upon some factors other than general intelligence. It is probable that the attitude of the pupils toward mathematics is a potent factor. It is also likely that diagnosis and remedial instruction might have assisted a number of the pupils. On the other hand it may be that mathematics requires a special type of intelligence and that the scores secured by means of general intelligence tests can be used only for a general survey of pupils with respect to their probable success in mathematics."

"Crathorne[1] (1922) finds that the correlation between algebra marks and an average of two intelligence tests is .50. Buckingham (1921) reports a correlation between algebra ratings and the scores on Army Alpha of .38. Proctor (1921) reports a correlation of .46 between algebra grades and the Stanford Binet I. Q.

Thorndike reports the following correlations between the algebra test in his intelligence examination for high school graduates and the whole examination.

371	candidates at Columbia	.47
77	candidates at Columbia	.53
76	candidates at Columbia	.50
321	candidates at Columbia	.41
465	candidates at Columbia	.46
132	candidates at Columbia	.47
180	candidates at an engineering school	.50
97	women candidates	.51

The Mann Report of Engineering Education (1918) gives the correlation between a thirty minute test in algebraic computation and an excellent criterion for intelligence as .62".

After necessary corrections were made in the results of the correlations reported by Thorndike and those from Horace Mann, Thorndike concludes, "that for high school freshmen as a group the correlation would be in the neighborhood of .70". He also states, that, "by and large, high intelligence means fine ability in algebra and low intelligence means poor ability in algebra."

It is the opinion of the writer of this thesis that the results of the investigations above quoted seem to prove that success in algebra depends not wholly upon general intelligence. Other factors, some of which cannot be measured, are also concerned.

CHAPTER III

THE SPECIFIC FIELD OF THE STUDY

It will be remembered that one of the facts the writer kept in mind during this investigation was that many changes have been made in methods of classification. It was hoped that from this study, additional truths might be revealed on this subject. This problem of classifying algebra pupils intelligently raised innumerable questions.

There was also a felt need for a criterion that could be used in predicting success in algebra. (Such a criterion is needed for use in advising pupils as to whether or not they should enroll in algebra.) It seemed the only way to thoroughly investigate these problems, was to study the factors of success in algebra.

Mental age, reading age, arithmetic reasoning ability, and ability in computation are factors which can be measured before a pupil enrolls for this subject. Therefore, a study was made of the relation of the above mentioned factors to achievement in algebra for two hundred-two pupils in Central Junior High School, Kansas City, Missouri.

Out of the many queries that arose from a consideration of these problems it was purposed in this study to disclose;

1. The relationship of each of the following factors: namely, mental age, reading age, arithmetic reasoning ability, and ability in computation with achievement in algebra.

2. To what extent each of these factors can be employed to predict success in algebra.

3. The possible application of the findings to the school situation in Central Junior High School.

CHAPTER IV

THE METHOD OF PROCEDURE AND FINDINGS

The pupils chosen for this study were those enrolled in first year algebra during the year 1925-1926, at Central Junior High School, Kansas City, Missouri. They were distributed among five algebra teachers, in eighteen different classes, with an average of thirty in each class.

All of the pupils in these classes were given the following tests: the Courtis Standard Research Tests in addition, subtraction, multiplication, and division; the National Intelligence Test; the Thorndike-McCall Reading Scale; the Stevenson Problem Analysis Test; and the Hotz First Year Algebra Scales. On account of absences when the tests were given and transfers to other schools a complete list of scores for all of these pupils could not be kept. Out of five hundred that were tested, complete data were finally available for each of two-hundred-two pupils. These were used as a basis for this study. Of these two hundred-two pupils, ninety-one or 45.0 percent were girls. Table I shows the distribution of the pupils according to age and sex.

TABLE I

DISTRIBUTION ACCORDING TO AGE AND SEX

Years	Girls	Boys	Total
11	1	0	1
12	4	5	9
13	38	41	79
14	51	21	72
15	15	19	34
16	2	4	6
17	0	1	1
Totals	111	91	202
Mean	13.73 years	13.77 years	13.74 years
S. D.	11.64 months	13.44 months	12.72 months

From the table it is seen that the boys' ages varied somewhat more than the girls'.

A. The Intelligence Scores.

The National Intelligence Test, Scale A, Form 1, was given in the spring of 1925, by members of the Research Department of the Kansas City Schools, to all of the seventh grade pupils of the city. The scores of all but sixteen of these two hundred-two pupils were taken from this test. These scores were turned into mental ages from tables furnished by the authors of the test. Since many of the scores received on this test were higher than those given in the table, interpolation was used to turn these into mental ages.

Sixteen of the two hundred-two intelligence scores were taken from the Terman Group Test, Form A. These were likewise

converted into mental ages.

Table II shows the distribution of these pupils according to mental age.

TABLE II

DISTRIBUTION IN MENTAL AGE FOR 202 ALGEBRA PUPILS

Score	Frequency
120-129	2
130-139	1
140-149	2
150-159	7
160-169	21
170-179	12
180-189	18
190-199	39
200-209	39
210-219	31
220-229	23
230-239	7
Total	202
Mean	196.74
S. D.	2.25

B. The Computation Scores.

The Courtis Standard Research Tests in Arithmetic, Series B, Form 4 were given in May, 1925 by the regular seventh grade teachers. The scores used on these tests were the number right.

Table III shows the distribution of these pupils according to addition scores.

TABLE III

DISTRIBUTION IN ADDITION FOR 202 ALGEBRA PUPILS

Score	Frequency
3	1
4	0
5	3
6	0
7	8
8	3
9	6
10	12
11	15
12	23
13	18
14	24
15	22
16	12
17	16
18	6
19	7
20	8
21	4
22	6
23	5
24	3
Total	202
Mean	14.76
S. D.	4.25

Table IV shows the distribution of these pupils according to subtraction scores.

TABLE IV

DISTRIBUTION IN SUBTRACTION FOR 202 ALGEBRA PUPILS

Score	Frequency
4	1
5	1
6	1
7	4
8	5
9	8
10	12
11	10
12	13
13	18
14	13
15	7
16	12
17	16
18	12
19	15
20	9
21	12
22	12
23	9
24	12
Total	202
Mean	16.43
S. D.	4.89

Table V shows the distribution of these pupils according to multiplication scores.

TABLE V

DISTRIBUTION IN MUMTIPLICATION FOR 202 ALGEBRA PUPILS

Score	Frequency
3	1
4	0
5	9
6	5
7	12
8	12
9	16
10	20
11	14
12	13
13	18
14	18
15	14
16	17
17	11
18	13
19	3
20	3
21	0
22	1
23	1
24	1
Total	202
Mean	12.82
S. D.	4.07

Table VI shows the distribution of these pupils according to division scores.

TABLE VI

DISTRIBUTION IN DIVISION FOR 202 ALGEBRA PUPILS

Score	Frequency
5	1
6	1
7	1
8	9
9	6
10	6
11	14
12	8
13	18
14	9
15	13
16	18
17	6
18	15
19	12
20	10
21	13
22	10
23	16
24	16
Total	202
Mean	17.04
S. D.	4.79

The mean scores of these pupils were compared with the standard medians of the Courtis Tests. These are shown below.

	Addition	Subtraction	Multiplication	Division
Mean	14.76	16.43	12.82	17.04
S. D.	4.25	4.89	4.07	4.79
Courtis Standards	12	13	11	11

The eighth grade standards were used in this comparison because there is no eighth grade in the Kansas City schools and the seventh grade pupils are expected to reach the eighth grade standard.

From this comparison, it is noticable that this group of pupils is above the Courtis Standards in all the fundamentals.

C. The Arithmetic Reasoning Scores

The Stevenson Problem Analysis Test, Form 2, was given in May, 1925, by the regular seventh grade teachers.

Table VII shows the distribution of these pupils according to arithmetic reasoning scores.

TABLE VII

DISTRIBUTION IN REASONING FOR 202 ALGEBRA PUPILS

Score	Frequency
12	1
13	1
14	0
15	6
16	1
17	4
18	9
19	9
20	10
21	38
22	35
23	31
24	57
Total	202
Mean	22.19
S. D.	2.57

D. The Reading Scale

The Thorndike-McCall Reading Scale, Form 1 was given in October, 1925, by the regular algebra teachers. The T scores were turned into reading ages.

Table VIII shows the distribution of these pupils according to reading age.

TABLE VIII

DISTRIBUTION IN READING AGE FOR 202 ALGEBRA PUPILS

Score	Frequency
140-144	3
145-149	0
150-154	3
155-159	5
160-164	7
165-169	15
170-174	0
175-179	23
180-184	20
185-189	0
190-194	38
195-199	0
200-204	43
205-209	0
210-214	0
215-219	26
220-224	0
225-229	15
230-234	0
235-239	4
Total	202
Mean	193.54
S. D.	4.17

E. The Algebra Scale.

Achievement in algebra was measured by the Hotz First Year Algebra Scales, Series A. The Addition and Subtraction Scale and the Equation and Formula Scale were given after three months study of algebra. The Multiplication and Division Scale and the Problem Scale were given after six months study. The Equation and Formula Scale (repeated) and the Graph Scale were given after nine months study. These algebra tests were given by the regular algebra teachers during the regular class periods.

Table IX shows the distribution of these pupils according to achievement in algebra.

TABLE IX

DISTRIBUTION IN ALGEBRA ACHIEVEMENT FOR 202 PUPILS.

Score	Frequency
-8 - (-7)	2
-7 - (-6)	5
-6 - (-5)	3
-5 - (-4)	6
-4 - (-3)	23
-3 - (-2)	15
-2 - (-1)	25
-1 - 0	35
0 - 1	35
1 - 2	28
2 - 3	12
3 - 4	11
4 - 5	2
Total	202
Mean	-.62
S.D.	2.45

The following method was used for finding an index for each child on the Hotz tests. The scores on the two tests given after three months study were added. Then the formula $\frac{X_1 - M_1}{T}$ was applied. X_1 is the score on the three months tests. M_1 is the mean of these scores, and T is the standard deviation of the scores. The same procedure was used for the other two series of tests; then the three results were added to give the final index that was used.

Table X shows the arithmetical mean and the standard deviation from this mean of the scores on each of the tests given.

TABLE X

THE MEAN SCORES AND STANDARD DEVIATIONS OF SCORES ON EACH TEST.

	Hotz Total	Mental Age	Reading Age	Stegenson Reasoning	Addition	Sub-traction	Multi-plication	Di-vision.
Mean	-.62	196.74	193.54	22.19	14.76	16.43	12.82	17.04
S.D.	2.45	2.25	4.17	2.57	4.25	4.89	4.07	4.79

Three of the tests given: namely, the Courtis Subtraction Test, the Courtis Division Test, and the Stevenson Analysis Test did not seem to measure this group of pupils. This is noticeable from the fact that most of the scores on these tests seemed to fall near the top of the distributions.

CHAPTER V.

THE INTERPRETATION OF FINDINGS

A. INTER-RELATIONSHIPS

The question of the relationships of intelligence, reading ability, arithmetic reasoning, and ability in computation with achievement in algebra was carried out by the method of correlation. The Pearson product moment formula, $r = \frac{\frac{\Sigma x'y'}{n} - cxcy}{\sigma x \sigma y}$, was used to find the correlation of each of the following factors with others: mental age, reading age, arithmetic reasoning ability, ability in multiplication, ability in subtraction, ability in addition, ability in division, and achievement in algebra. The probable error was computed by the formula, $P.E. = .6745 \frac{1 - r^2}{\sqrt{n}}$.

The regression coefficients were also derived to aid in more completely describing the relationships. The regression equations $x = r \frac{\sigma x}{\sigma y} y$ and $y = r \frac{\sigma y}{\sigma x} x$ were used to find these coefficients. The first of these equations, namely, $x = r \frac{\sigma x}{\sigma y} y$ "measures the probable deviation of an x- measure from the average x, corresponding to a known deviation in the y- measure from the average y." Likewise, the equation $y = \frac{\sigma y}{\sigma x} x$ "measures the most probable deviation of any y- measure from the mean y corresponding to a known deviation in the x measure from the mean x."

By means of these equations, if one knows the correlation between two measures, then, given the score on one measure he can predict the most probable score that will be made on the other measure.

In interpreting the correlations found in this chapter, use was made of the table given by Rugg. He regards "Correlation as 'Negligible' or 'indifferent' when r is less than .15 to .20; as being'present but low' when r ranges from .15 or .20 to .35 or .40; as being 'markedly present' or 'marked' when r ranges from .35 or .40 to .50 or .60; as being 'high' when it is above .60 or .70".

It was the object of these studies to find out whether any relationships and how much existed between these factors.

Table XI

The coefficient of correlation between multiplicationmand division was .70±.02. The correlation was high as one would expect to find it. That is, pupils above the average in multiplication will tend to be above the average in division. The regression equations indicated that the most probable deviation of any pupil from the mean score in division was .82 times as great as his deviation from the mean in multiplication. Also, the most probable deviation of any pupil from the mean in multiplication was .59 times as great as his deviation from the mean in division.

One would expect the results found here because of the nature of these two arithmetical processes.

TABLE XI

CORRELATION OF COURTIS MULTIPLICATION SCORES WITH COURTIS DIVISION SCORES FOR 202 JUNIOR HIGH SCHOOL PUPILS

Division Scores	Multiplication Scores																					
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24										1	2	1		1	3	5	2	1					16
23									1		1	2	2	3	2		1	2		1		1	16
22										1		3	1	2	1	2							10
21					1		1	1			2	2	1	4							1		13
20							1	1	3		1		1		1	2							10
19						1		2		1	1		3	2	1	1							12
18							1	4	2	1		1	2	2	1	1							15
17								1		1	2	1		1									6
16						3	1	3	2	2		2	1	1	1	2							18
15					2	3	2	1	1			2	2										13
14			1			1		1	1	1	3	1											9
13					1	2	1	2	2	2	3	2	1	1	1								18
12			3	1			1	1	1			1											8
11				2	3	2	2	1		2	2												14
10			2				2	1		1													6
9				1	2		2				1												6
8	1		3	1	1		1	1	1														9
7					1																		1
6							1																1
5					1																		1
4																							
3																							
	1	0	9	5	12		16	20	14	13	18	14	17	11	13	3	3	0	1	1	1		202

$\sigma_y = 4.79$ $\quad r = .70$

$\sigma_x = 4.07$ $\quad$ P. E. $= .02$

$y = .82\,x$

$x = .59\,y$

TABLE XII

CORRELATION OF COURTIS DIVISION SCORES

WITH COURTIS SUBTRACTION SCORES.

Division Scores	Subtraction Scores. 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	T
24														1	1	1	1	2	2	1	3	4	16
23														1			1	4	3	3	3	1	16
22													1		1	1			2	2	1	2	10
21											1	1		2	1		2	1	1	3		1	13
20											3		2		1	1	1					2	10
19													1	2	3	1	4		1				12
18							1			1		1		1	1	4	2	1	1	2			15
17											2	1	1						1		1		6
16					1	1	1	2	2	1	1	2	1	2	1				1	1		1	18
15							1				4	2		2	1	1	1	1					13
14								1	2	1	1	2			1		1						9
13							1	4	1	2	1				3	2	2				1	1	18
12					1	1				2	2	2											8
11				1			2	1	2	4		2	1			1							14
10								1		1	3				1								6
9			1				1	1	2					1									6
8		1			1	1	1	2	1	1					1								9
7					1																		1
6						1																	1
5						1																	1
	1	1	1	4	5	8	12	10	13	18	13	7	12	16	12	15	9	12	12	9	12	202	

$\sigma x = 4.89$ $r = .68$

$\sigma y = 4.79$ P.E. $= .02$

$x = .69\ y$

$y = .69\ x$

TABLE XIII

CORRELATION OF COURTIS MULTIPLICATION

SCORES WITH COURTIS SUBTRACTION SCORES.

Multiplication scores \ Subtraction Scores	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24																				1			1
23																				1			1
22																					1		1
21																							0
20																	1			1		1	3
19																		1	1		1		3
18									1						2	3			2			5	13
17															2	1	1	1	3		1	2	11
16											1	1			1	2	2	3	5	2			17
15													1	2	1		1	2	1	2	2	2	14
14											2	2	1	2	2	2	2			3	1	1	18
13							1		2		2	2		1		1	4	1			3	1	18
12								2		2	1	1	2	2	2					1			13
11							1	2	1		4	1	1	1	1	1	1						14
10					1	1	1	1	1	5	2	2		2	2		2			1			20
9			1		1		2	1		2	3		1	1	2	1							16
8							1	1	2		1	3	1		1	1	1						12
7						2		3	2	1				1				1					12
6									2	1	2												5
5						1	1	1	2		1	2	1										9
4																							0
3		1																					1
2																							
	1	1	1	4	5	8	12	10	13	18	13	12	16	12	15	9	12	12	9	12	202		

$\sigma x = 4.89$ r = .71

$\sigma y = 4.07$ P. E.= .02

x = .85 y

y = .59 x

TABLE XIV

CORRELATION OF COURTIS ADDITION SCORES

WITH COURTIS DIVISION SCORES.

Division Scores \ Addition Scores	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24										2	1			1	1	1	2	2	1	2		3	16
23										1			3	1	2			2	2	2	3		16
22									1			1	1	1	3		1			2			10
21										1	3	3			2	2	1				1		13
20											1	3	1	1	1	2		1					10
19									1	1	1	2	3	1	1		1	1					12
18							1	1	1	2	1	3	1	2	2		1						15
17							1				2	1		1	1								6
16					1		1	2		3	2	2	2	1	1	1	1	1					18
15					1	1		1	2	1	2	2	1	1					1				13
14								2	2	1		2	1		1								9
13			1			2	1	1	2		1	2	5	1	1							1	18
12					1		1	1	1	2	1		1										8
11	1							1	3	4	1		2	1				1					14
10							1	1		1	1	1	1										6
9			1						2	3													6
8			1		3			2			1	2											9
7					1																		1
6										1													1
5					1																		1
Total	1	0	3	0	8	3	6	12	15	23	18	24	22	12	16	6	7	8	4	6	5	3	

$\sigma x = 4.25$ $\quad r = .62$

$\sigma y = 4.79$ $\quad P.E. = .03$

$x = .55\ y$

$y = .69\ x$

Table XII

There was found to exist a high relationship between ability in division and ability in subtraction. The correlation of subtraction scores with division scores was .68 ± .02. From the regression equations it is seen that a unit deviation in division will probably be accompanied by a deviation of .69 as much in subtraction. Also, a unit deviation in subtraction will probably be accompanied by a deviation of .69 times as much in division.

Table XIII

The correlation between multiplication and subtraction showed a high relationship as is indicated by r = .71 ± .02. It is evident from the first regression equation that a deviation of one unit from the mean of the scores in multiplication is most probably accompanied by a deviation of .85 times as much from the mean of the scores in subtraction. From the second equation, it is evident that a unit deviation in subtraction will probably be accompanied by a deviation of .59 times as much in multiplication.

Table XIV

A marked relationship was found to exist between addition and division. The coefficient of correlation was .62 ± .03. The regression equations disclosed that a unit deviation in division will probably be accompanied by a deviation of .55 as much in addition. Also, a unit deviation in addition will probably be accompanied by a deviation of .69 as much in division.

TABLE XV

CORRELATION OF COURTIS ADDITION SCORES

WITH COURTIS MULTIPLICATION SCORES.

Addition Scores

Multiplication scores	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24																					1		1
23																					1		1
22																					1		1
21																							0
20															1				1	1			3
19															1			1		1			3
18										1		1	1	1	2	1	1	2		2		1	13
17													3		1	1	1	1	1	1		2	11
16										2		1	2	3	3	2	2	2					17
15										2	2	2	3	1		1	1		1		1		14
14								1		1	2	1	5	2	3	1	1			1			18
13									3	2	2	2	2	1	2			2	1		1		18
12								2	1	1	2	2	1	2	1		1						13
11						1		1	2	1	3	3	1	1	1								14
10							4	3	1	3	1	5	2		1								20
9	1				1		2		2	4	1	5											16
8			1		1	2			2	2	1	2		1									12
7			1		4				3	1	2		1										12
6					1				1	2			1										5
5			1		1			4		1	2												9
4																							0
3								1															1
	1	0	3	0	8	3	6	12	15	23	18	24	22	12	16	6	7	8	4	6	5	3	202

$\sigma x = 4.25$ $\quad r = .70$

$\sigma y = 4.07$ $\quad$ P.E. = .02

$x = .73\ y$

$y = .67\ x$

TABLE XVI

CORRELATION OF COURTIS ADDITION SCORES

WITH COURTIS SUBTRACTION SCORES

Addition Scores \ Subtraction Scores	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22x23	24	T
24																			1		2	3
23									1										1	2 1		5
22																1			2	1	2	6
21																		2		1 1		4
20							1	1										2	2	1	1	8
19																1			2	3	1	7
18															1	1				2 1	1	6
17										1	1	1	1	1		2	3	1	1	1 1	2	16
16									1	1			1		2	3	2		2			12
15								1		1	1	2		1	5	1	3	1		3	3	22
14					1				2	1	5	3	1	1	4		4	1	1			24
13						1	1			1	4		2	4	1	1	1	1			1	18
12			1		1	1		2	1	3		5		4	1	1	1	1			1	23
11							2	1	4	1	3		1		1	1					1	15
10		1				1	1	3		2	1	1		1	1							12
9						1		1		1	1	1					1					6
8							1	1			1											3
7					2	1	1	1		1	1		1									8
6																						0
5							1	2														3
4																						0
3				1																		1
Total	0	1	1	1	4	5	8	12	10	13	18	13	7	12	16	12	15	9	12	18	9	12	202

$\sigma x = 4.89$ $\quad r = .64$

$\sigma y = 4.25$ $\quad P.E. = .03$

$x = .73\ y$

$y = .55\ x$

TABLE XVII

CORRELATION OF COURTIS DIVISION SCORES WITH

STEVENSON PROBLEM ANALYSIS SCORES.

	Stevenson Scores													
	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Division Scores							1			2	1	4	8	16
24				1				1	2	1	3		8	16
23							1			2	3	2	2	10
22						1		2			4	2	4	13
21								1		1	2	2	4	10
20										4	2	1	5	12
19										5	1	3	6	15
18								2		2	1		1	6
17				1	1		1		1	7	1	4	2	18
16							2		1	3	2	2	3	13
15														
14		1				1		1	1	1	1	1	2	9
13				1			1	1		4	5	2	4	18
12							1				3	3	1	8
11	1			1					3	3	3	1	2	14
10						1		1		1		1	2	6
9				1					1	2	1	1		6
8						1	1	1			2	1	3	9
7												1		1
6				1										1
5							1							1
Total	1	1	0	6	1	4	9	9	10	38	35	31	57	202

$\sigma x = 2.57$ $\quad r = .24$

$\sigma y = 4.79$ $\quad$ P.E. = .04

$x = .13\ y$

$y = .45\ x$

Table XV

A high correlation was found between addition and multiplication. The coefficient of correlation was .70 ± .02. This is a higher correlation than was found by Schreiber[1] .when he used these same factors. He found a correlation of .646 ± .03 between addition and multiplication.

Table XVI

The coefficient of correlation .64 ± .03 between addition and subtraction shows a marked relationship between these two factors. A unit deviation from the mean of the scores in subtraction will probably be accompanied by a deviation of .73 as much in addition. A unit deviation from the mean of the scores in addition will probably be accompanied by a deviation of .55 as much in subtraction.

Table XVII

The coefficient of correlation was found to be .24 ± .04 between division and reasoning ability. This shows that correlation is present but low. A unit deviation from the mean of the scores in division will probably be accompanied by a deviation of .13 as much in reasoning. A unit deviation from the mean of the scores in reasoning ability will probably be accompanied by a deviation of .45 as much in division.

Table XVIII

Correlation between reasoning ability and multiplication was present but low as the coefficient of correlation .19 ± .05

TABLE XVIII

CORRELATION OF COURTIS MULTIPLICATION

SCORES WITH STEVENSON PROBLEM ANALYSIS SCORES

Multiplication Scores	Stevenson Scores 12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24													1	1
23								1						1
22								1						1
21														0
20										1			2	3
19													3	3
18							1			4	2	4	2	13
17				1					1	1	1	2	5	11
16									1	4	6	2	4	17
15								1	1	3		5	4	14
14							2	1		2	4	3	6	18
13	1					2		1		4	4	1	5	18
12							1	1	1	2	3	2	3	13
11										2	6	3	3	14
10				1	1					4	4	1	9	20
9				1					2	7	1	2	3	16
8		1		1			2	1		3	2	1	1	12
7							1	1	2	1	1	3	3	12
6				2		1	1		1					5
5						1		1	1		1	2	3	9
4														0
3							1							1
Total	1	1	0	6	1	4	9	9	10	38	35	31	57	202

$\bar{x}$ = 2.57 r = .19

$\bar{y}$ = 4.07 P.E. = .05

x = .12y

y = .30x

TABLE XIX

CORRELATION OF COURTIS SUBTRACTION SCORES

WITH STEVENSON PROBLEM ANALYSIS SCORES.

Subtraction Scores	Stevenson Scores 12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24							1	1		1	1	5	5	12
23								2			2	1	4	9
22							1	1			3	2	5	12
21				1						1	2	2	6	12
20								1	3	1		2	2	9
19										3	4		8	15
18							1			4	3	4		12
17				1				1		5	4	1	4	16
16						1			1	1	1	3	5	12
15				1						2	3		1	7
14						1				3	3		6	13
13						1	1	1		8	2	3	2	18
12				1	1		1		1	1	3	1	4	13
11		1							1	5	2	1		10
10				1		1	2	1	1		2	2	2	12
9	1							1	3			2	1	8
8		1					1					1	2	5
7										1		1	2	4
6												1		1
5												1		1
4							1							1
Total	1	2	0	6	1	4	9	9	10	38	35	31	57	202

$\sigma x = 2.57$ $\quad r = .23$

$\sigma y = 4.89$ $\quad$ P.E. $= .04$

$x = .12y$

$y = .44x$

shows. It was found that for every unit deviation from the mean in multiplication, it is most probable that there will be an accompanying deviation of .12 as much in reasoning and that for every unit deviation from the mean in reasoning, it is most probable that there will be an accompanying deviation of .30 as much in multiplication.

Table XIX

The coefficient of correlation found between reasoning ability and subtraction was .23 ± .04. This shows that correlation was present but low between these two factors. From the regression equations it is seen that a unit deviation in subtraction will probably be accompanied by a deviation of .12 as much in reasoning. Also, a unit deviation in reasoning will probably be accompanied by a deviation of .44 as much in subtraction.

Table XX

There was a negligible relationship found between reasoning ability and addition. The coefficient of correlation found was .14 ± .05. The first regression coefficient is too small to indicate anything. From the second equation, it is evident that a unit deviation in reasoning will probably be accompanied by a deviation of .23 times as much in addition.

TABLE XX

CORRELATION OF COURTIS ADDITION SCORES

WITH STEVENSON PROBLEM ANALYSIS SCORES

Addition Scores	Stevenson Scores 12	13	14	15	16	17	18	19	20	21	22	23	24	Total
24													3	3
23								2		1			2	5
22											2	1	3	6
21									2				2	4
20	1			1						1		2	3	8
19							1			1	1	3	1	7
18								1			2	1	2	6
17						1		1		4	4	2	4	16
16							1			3	4	2	2	12
15				1				1	1	4	5	3	7	22
14			1					1		8	3	2	9	24
13						2		1	1	3	4	3	4	18
12				2			1		3	5	3	3	6	23
11							1		1	5	4	2	2	15
10				1			2	1	2	1	2		3	12
9					1					1		2	2	6
8							1	1			1			3
7				1		1	1					3	2	8
6														0
5							1					2		3
4														0
3										1				1
Total	1	1	0	6	1	4	9	9	10	38	35	31	57	202

$\sigma x = 2.57$ $r = .14$

$\sigma y = 4.25$ P.E. $= .05$

$x = .08y$

$y = .23x$

TABLE XXI

CORRELATION OF COURTIS DIVISION SCORES

WITH THORNDIKE -McCALL READING AGES

Division Scores	Reading Ages 140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	Tota
24						1			2		4		2			4		3			16
23				1	1	1			3		3		3			2		2			16
22				1	1	1		2			2		2							1	10
21					1	1		2	1		1		5			2					13
20						1		1	1		4		2			1					10
19	1					1		2	1		1		1			4				1	12
18			1					2	1		1		4			1		4		1	15
17					1						3		1					1			6
16	1							5	3		3		3			2		1			18
15	1							2	1		2		5					2			13
14				1		1		1			3		3								9
13			1	2	1	2		1			4		3			4					18
12					2			2	1		2					1					8
11			1			2			2		3		3			2		1			14
10											3					2		1			6
9						2		1	2		1										6
8						1		2	1		1		2			1				1	9
7													1								1
6						1															1
5								1													1
Total	3	0	3	5	7	15	0	23	20	0	38	0	43	0	0	26	0	15	0	4	202

$\sigma x = 20.85$ $\quad r = .13$

$\sigma y = 4.79$ $\quad$ P.E. $= .05$

$x = .11y$

$y = .15x$

TABLE XXII

CORRELATION OF COURTIS MULTIPLICATION SCORES

WITH THORNDIKE-McCALL READING AGES.

Multiplication Scores	Reading Ages. 140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	f
24																		1			1
23																1					1
22											1										1
21																					0
20									2		1										3
19											1					2					3
18				1				2	2		3		2			2		1			13
17								1	1		4		2			1		1		1	11
16				1	1			2	1		3		5			3		1			17
15						1		1			2		6			2		2			14
14					1	3		4			4		5			1					18
13	1			1		1		1	2		4		4			2		2			18
12				1		3		2			2		3			1		1			13
11				1	2			2	3		1		2			2				1	14
10						3		3	1		6		4			1		2			20
9			1			1		2	2		1		4			5					16
8	1		1		1	1		1	2		1		1			1		1		1	12
7	1				1	1			2		2		2			1		2			12
6			1		1			2								1					5
5						1			1		2		3					1		1	9
4																					0
3									1												1
Total	3	0	3	5	7	15	0	23	20	0	38	0	43	0	0	26	0	15	0	4	202

$\sigma x = 20.85$ $\quad r = .12$

$\sigma y = 4.07$ $\quad$ P. E. = .05

$x = .12y$

$y = .12x$

TABLE XXIII

CORRELATION OF COURTIS SUBTRACTION SCORES

WITH THORNDIKE-McCALL READING AGES.

Subtraction Scores	Reading Ages 140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	T
24								1	1		3		3			2		1		1	12
23						1					3		3			1		1			9
22						2		1	1				5			1		2			12
21					1				2		5		2			1		1			12
20				1	1			1					2			3		1			9
19	1				1				1		6		1			2		3			15
18			1	1		1		2			2		2			3					12
17				1		3		2	2		2		3			1		1		1	16
16	1					1		4	1				1			3		1			12
15	1				1	1		1	1				1			1					7
14								1	2		4		6								13
13					1	1		3	2		4		4			1		2			18
12			1		1	1		1	1		2		3			2		1			13
11				2		2		2			2					2					10
10			1					2	1		3		3			1				1	12
9					1			1	2		1		1					1		1	8
8				2					1				1			1					5
7								1			1		2								4
6																1					1
5									1												1
4									1												1
Total	3	0	3	5	7	15	0	23	20	0	38	0	43	0	0	26	0	15	0	4	202

$\sigma x = 20.85$ $\quad r = .14$

$\sigma y = 4.89$ $\quad$ P. E. = .05

$x = .12\ y$

$y = .16\ x$

Table XXI

The coefficient of correlation .13 ± .05 between reading and division shows an important relationship between these two factors. The regression equations disclosed that a unit deviation in division will probably be accompanied by a deviation of .11 as much in reading ability. Also, a unit deviation in reading ability will probably be accompanied by a deviation of .15 as much in division.

Table XXII

The relationship between reading and multiplication, as shown by the coefficient of correlation .12 ± .05 is negligible. The regression coefficients that followed from this relationship were the same, both being .12.

Table XXIII

A negligible relationship was found between reading and subtraction. The coefficient of correlation found was only .14 ± .05. A unit deviation from the mean of the scores in subtraction will probably be accompanied by a deviation of .12 as much in reading ability. A unit deviation from the mean of the scores in reading will probably be accompanied by a deviation of .16 as much in subtraction.

TABLE XXIV

CORRELATION OF COURTIS ADDITION SCORES

WITH THORNDIKE-McCALL READING AGES.

Addition Scores \ Reading Ages	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	T
24									1							1		1			3
23				1							1		1			1		1			5
22						1			1		3									1	6
21									1				2					1			4
20								1	1		1		1			3		1			8
19						2					1		4								7
18								1			1		3			1					6
17				1		1		3	2		2		5			1		1			16
16				1	2			1	1		3		2			2					12
15			1	1		1		3	1		7		5			2		1			22
14	1					2		5	3		3		4			3		2			24
13	1				3	3		2	1		2		1			3		2			18
12			1			1		3	4		4		4			3		3			23
11				1	1	3		2	1		1		2			2				2	15
10						1			1		5		4			1					12
9											2		2			1		1			6
8					1						1		1								3
7	1							1	2				2			1		1			8
6																					0
5			1								1									1	3
4																					0
3																1					1
Total	3	0	3	5	7	15	0	23	20	0	38	0	43	0	0	26	0	15	0	4	202

σ_x = 20.85 r = .04

σ_y = 4.25 P.E. = .05

x = .04 y

y = .04 x

TABLE XXV

CORRELATION OF STEVENSON PROBLEM ANALYSIS

SCORES WITH THORNDIKE-McCALL READING AGES.

Reading Ages	Stevenson Scores 12	13	14	15	16	17	18	19	20	21	22	23	24	Total
235											1	2	1	4
230														0
225						1		1	1	1	1	4	6	15
220														0
215								1	1	7	3	3	11	26
210														0
205														0
200						1		2	3	4	9	7	17	43
195														0
190				1	1		3	2	1	6	8	5	11	38
185														0
180	1						2		2	7	1	2	5	20
175		1		1		2	1		1	10	4	1	2	23
170														0
165				2			1	1		1	3	5	2	15
160							1	2			3	1		7
155									1	1	2	1		5
150				1			1			1				3
145														0
140				½									2	3
Total	1	1	0	6	1	4	9	9	10	38	35	31	57	202

σx = 2.57 r = .27

σy = 20.85 P.E. = .04

x = .16y

y = .44x

TABLE XXVI

CORRELATION OF COURTIS DIVISION SCORES

WITH MENTAL AGES.

	Mental Ages												
	120	130	140	150	160	170	180	190	200	210	220	230	Total
Division Scores													
24								2	3	5	5	1	16
23					2		2	2	3	3	3	1	16
22						1	1	1	4		2	1	10
21					1		2	3	4	3			13
20						1		2	5	1	1		10
19				1	1	1	1	3	2	3			12
18				1	3		1	2	3	2	2	1	15
17				1	1			1	2		1		6
16	1				2	2	2	3	3	2	3		18
15	1				1	2	2	3	1		3		13
14					2		2	4		2			9
13			1	2	2	1		5	2	2	1	2	18
12			1		1	2		2	1	1			8
11		1			3	1	1	2	4	2			14
10								2		2	1		6
9				1	2			2			1		6
8				1		1	4		1	1		1	9
7										1			1
6										1			1
5									1				1
Total	2	1	2	7	21	12	18	39	39	31	23	7	202

$\sigma x = 22.54$ $\quad r = .25$

$\sigma y = 4.79$ $\quad$ P.E.= .04

$x = .11y$

$y = .53x$

Table XXIV

No relationship was found between reading age and addition. The coefficient of correlation between these two factors was .04 ± .05. The regression coefficients did not contribute any significance to the influence of elements involved in this relationship.

Table XXV

Correlation was found to be present but low between reading age and reasoning ability. This is shown by the coefficient of correlation .27 ± .04. A unit deviation from the mean of the scores in reading will probably be accompanied by a deviation of .16 as much in reasoning ability. A unit deviation from the mean of the scores in reasoning will probably be accompanied by a deviation of .44 as much in reading ability.

Table XXVI

Correlation between mental age and division was present but low as is shown by r = .25 ± .04. It was found that for every unit deviation from the mean in division, it is most probable that there will be accompanying deviation of .11 as much in mental age and that for every unit deviation from the mean in mental age, it is most probable that there will be an accompanying deviation of .53 as much in division.

TABLE XXVII

CORRELATION OF COURTIS MULTILICATION

SCORES WITH MENTAL AGES.

Multiplication Scores	Mental Ages 120	130	140	150	160	170	180	190	200	210	220	230	Total
24											1		1
23										1			1
22										1			1
21													0
20							1				2		3
19										2	1		3
18						1		5	4	3			13
17					2		1	1	3	2	1	1	11
16					1	2	1	4	3	3	2	1	17
15				1	2			2	4	1	3	1	14
14				1	2	2		4	4	1	4		18
13				1	4		2	4	3	2	1	1	18
12					3	2	2	2	1	2	1		13
11					2		1	4	3	1	2	1	14
10			1	2	1	2	2	4	6		1	1	20
9				1	1	2	2	2	3	4	1		16
8	1		1		1		2	2	2	2	1		12
7	1				1		1	1	3	3	2		12
6		1			1		1	1		1			5
5						1	2	3		2		1	9
4													0
3				1									1
Total	2	1	2	7	21	12	18	39	39	31	23	7	202

$\sigma x = 22.54$ $\quad r = .21$

$\sigma y = 4.07$ $\quad$ P. E. = .05

$x = .12\ y$

$y = .38\ x$

TABLE XXVIII

CORRELATION OF COURTIS SUBTRACTION SCORES

WITH MENTAL AGES.

Subtraction Scores	Mental Ages. 120	130	140	150	160	170	180	190	200	210	220	230	Total
24							1	4	2	1	3	1	12
23								2	2	2	1	2	9
22					2			1	3	1	5		12
21					1			2	6	2	1		12
20					1		2	1	1	2	1	1	9
19					2		1	3	3	2	2	1	15
18				1	1	1	1	3	2	2		1	12
17				2	2	2	1	3	1	4	1		16
16	1			1	1	1	2	2	1		3		12
15	1				1		1		3	1			7
14				1		2	3	2	2	1	1		13
13					3	2	1	5	3	3	1		18
12		1	1		3	2		2	2	2			13
11				1	2	1	1	3		2			10
10			1		1		3	2	1	2	2		12
9					1			2	2		2	1	8
8						1	1		1	2			5
7								1	2	1			4
6									1				1
5				1									1
4								1					1
Total	2	1	2	7	21	12	18	39	39	31	23	7	202

$\sigma x = 22.54$ $\quad r = .22$

$\sigma y = 4.89$ $\quad P.E. = .05$

$x = .10y$

$y = .47x$

Table XXVII

This study disclosed a correlation present but low between mental age and ability in multiplication. The coefficient of correlation found was .21 ± .05. From the regression equations it is seen that a unit deviation in multiplication will probably be accompanied by a deviation of .12 as much in mental age. Also a unit deviation in mental age will probably be accompanied by a deviation of .38 as much in multiplication.

This agrees closely with what Schreiber[1] found in his study. He found the coefficient between these two factors to be .256 ± .05.

Table XXVIII

The correlation between mental age and subtraction was found to be present but low. The coefficient of correlation found was .22 ± .05. It is evident from the first regression equation that a deviation of one unit from the mean of the scores in subtraction is most probably accompanied by a deviation of .10 times as much from the mean of the scores in mental age. From the second equation, it is evident that a unit deviation in mental age will probably be accompanied by a deviation of .47 times as much in subtraction.

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TABLE XXIX

CORRELATION OF COURTIS ADDITION SCORES

WITH MENTAL AGES.

Addition Scores	MENTAL AGES 120	130	140	150	160	170	180	190	200	210	220	230	240	250	Total
24									2		1				3
23				1					1	2	1				5
22							1	1	1	1	1	1			6
21								1	1		1	1			4
20					2			2	1	2		1			8
19					1			2	2	2					7
18					1	1		3			1				6
17					1		3	1	2	4	5				16
16				1	1	1		3	3	3					12
15		1			3	1	1	4	7	2	2	1			22
14					3	4	2	5	5	4	1				24
13	1			1	2		4		6	1	2	1			18
12			1	1	1	2	1	8	2	3	4				23
11					3		3	5	1	3					15
10				2	2	2	1	3		1		1			12
9				1				1	1	1	1	1			6
8					1				1		1				3
7	1					1	1	2	2		1				8
6															0
5			1				1				1				3
4															0
3								1							1
Total	2	1	2	7	21	12	18	39	39	31	23	7			

σ_x = 22.54 r = .17

σ_y = 4.25 P.E. = .05

$x = .09y$

$y = .32x$

TABLE XXX

CORRELATION OF MENTAL AGES WITH

STEVENSON PROBLEM ANALYSIS SCORES.

Stevenson Scores \ Mental ages	120	130	140	150	160	170	180	190	200	210	220	230	240	Total
24	1				4	2	4	9	17	9	8	3		57
23				2	2	2	1	2	6	6	8	2		31
22			1		4	5	2	11	5	4	2	1		35
21				2	5	3	5	10	5	5	3			38
20				1	1		1	2	2	2		1		10
19					1		1	1	1	3	2			9
18			1	1	2		1	2	2					9
17							3			1				4
16									1					1
15	1	1		1	1			1		1				6
14														0
13								1						1
12					1									1
Total	2	1	2	7	21	12	18	39	39	31	23	7		202

$\sigma x = 22.54$ $\quad r = .27$

$\sigma y = 2.57$ $\quad P.E. = .04$

$x = 24y$

$y = .31x$

Table XXIX

The relationship between addition and mental age was found to be less than that of any of the other five factors that were compared with mental age. This is shown by the coefficient of correlation .17 ± .05. Correlation was present but low. A unit deviation from the mean of the scores in addition will probably be accompanied by a deviation of .09 as much in mental age. A unit deviation from the mean of the scores in mental age will probably be accompanied by a deviation of .32 as much in addition.

Schreiber[1] found a much higher correlation than this between these two factors. His correlation was .342 ± .05.

Table XXX

The relationship between mental age and reasoning ability was found to be the same as between reading age and reasoning ability. The coefficient of correlation .27 ± .04 shows that correlation was present but low. It was found that for every unit deviation from the mean in reasoning ability, it is most probable that there will be an accompanying deviation of .24 as much in mental age and that for every unit deviation from the mean in mental age, it is most probable

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TABLE XXXI

CORRELATION OF MENTAL AGES WITH

THORNDIKE-McCALL READING AGES.

Reading Ages	Mental Ages. 120	130	140	150	160	170	180	190	200	210	220	230	240	Total
235							1	1		1		1		4
230														0
225							1	2	1	3	6	2		15
220														0
215						1		5	4	11	3	2		26
210														0
205														0
200				2	1	5	1	11	10	7	6	1		43
195														0
190				1	6	2	3	5	10	5	5	1		38
185														0
180				2	2	1	2	4	3	3	3			20
175			1		3	3	7	7	2					23
170														0
165				2	5		1	1	5	1				15
160					2		1	1	3					7
155				1			1	2	1					5
150		1	1		1									3
145														0
140	2				1									3
Total	2	1	2	7	21	12	18	39	39	31	23	7		202

σ_x = 22.54 r = .53

σ_y = 20.85 P. E.= .03

x = .27y

y = .98x

TABLE XXXII

CORRELATION OF COURTIS DIVISION SCORES

WITH HOTZ TOTAL SCORES

	Hotz Scores													
	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	Total
Division Scores															
24			1				2	3	6	1	2	1			16
23				1		1	2	2	4	2	2	1	1		16
22					1	1	1		1	3	1	1	1		10
21	1				1		2	2	5	2					13
20								3		3	3	1			10
19			1	1		1	1	3	3	2					12
18				1	1		1	3	3	5		1			15
17					1	1	1		1	2					6
16		1		1	4	1	3	2	5			1			18
15		1				2	3	5		1		1			13
14	1					1			3	2	2				9
13		1	1	1	4	2	1	2	1	2		3			18
12					2	2	3	1	1						8
11		2			4	1	2	2	2	1					14
10				1	1			2			1	1			6
9							1	3		1	1				6
8					3	1	2	2	1						9
7					1										1
6					1										1
5						1									1
Total	2	5	3	6	23	15	25	35	36	27	12	11	2		202

$\sigma x = 2.45$ $\quad r = .29$

$\sigma y = 4.79$ $\quad$ P.E. $= .04$

$x = .15y$

$y = .56x$

that there will be an accompanying deviation of .31 as much in reasoning.

TABLE XXXI

Mental age and reading age in this investigation had a marked relationship. The correlation between mental age and reading age was .53 ± .03. From the regression equations it is seen that a unit deviation in reading age will probably be accompanied by a deviation of .27 as much in mental age. Also, a unit deviation in mental age will probably be accompanied by a deviation of .98 as much in reading age.

Monroe[1] found a similar correlation of .52 ± .09 between Otis scores and the Trabue Language, L & M.

TABLE XXXII

The correlation between ability in algebra, as measured by the Hotz First Year Algebra Scales, and division was .29 ± .04. This coefficient of correlation although low shows that there is present a relationship between these two factors. From the regression equations it is seen that a unit deviation in division will probably be accompanied by a deviation of .15 as much in achievement in algebra. Also a unit deviation in achievement in algebra will probably

TABLE XXXIII

CORRELATION OF COURTIS MULTIPLICATION

SCORES WITH HOTZ TOTAL SCORES.

	Hotz Scores													
Multiplication Scores	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	Total
24											1			1
23									1					1
22								1						1
21														0
20									1		1	1		3
19									1	2				3
18					2		3	3	3	1	1			13
17							3	2	3		1	2		11
16							1	4	6	6				17
15			1		1		2	4	3	2			1	14
14		1		1	1	4		5	4	1	1			18
13				1	2		2	2	4	3	1	2	1	18
12		1	1		3	1		1	3	3	1			13
11	1			1	1		4	1		2	2	2		14
10		1	1		1	3	2	4	1	3	2	2		20
9				2	2		2	4	4	1	1			16
8				1	2	2	3	1	2	1				12
7	1	1			2	2	1	2		2		1		12
6		1			2	1	1							5
5					3	2	1	1	1			1		9
4														0
3					1									1
Total	2	5	3	6	23	15	25	35	36	27	12	11	2	202

$\sigma x = 2.45$ $r = .30$

$\sigma y = 4.07$ P.E. $= .04$

$x = .18y$

$y = .49x$

TABLE XXXIV

CORRELATION OF COURTIS SUBTRACTION SCORES WITH HOTZ TOTAL SCORES

Subtraction Scores	Hotz Scores													
	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	Total
24							3	1	3	1	2	2		12
23						1	1	2	2	1			2	9
22			1		1	1		2	3	1	2	1		12
21							3	2	4	3				12
20	1						1	2	3	1		1		9
19		1		2			2	2	3	4	1			15
18				1	1	1		2	3	2	1	1		27
17			2		1	1	1	5	2	3		1		16
16		1			1	1	1	3	4	1				12
15		1		1	1			1		2	1			7
14					1	3	1	2	1	4	1			13
13				2	2		5	4	1	2	1	1		18
12		1			3	1	3	2	1		1	1		13
11	1				2		1	2	4					10
10					3	3	2	2			1	1		12
9					3	1	1			2		1		8
8					1	2			1			1		5
7		1			2			1						4
6									1					1
5											1			1
4					1									1
Total	2	5	3	6	23	15	25	35	36	27	12	11	2	202

$\sigma_x = 2.45$ $\quad r = .25$

$\sigma_y = 4.89$ $\quad$ P.E.= .04

$x = .13y$

$y = .49x$

TABLE XXXV

CORRELATION OF COURTIS ADDITION SCORES

WITH HOTZ TOTAL SCORES

	Hotz Scores													
	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	Total
Addition Scores														
24									2		1			3
23								1	2	1	1			5
22						1	1		1		2	1		6
21								1	2			1		4
20					2		1	2	1	1		1		8
19			1		1	1	2	1	1					7
18								3	1	2				6
17					2	1			7	4	2			16
16				1	2	1	1	2	2	2	1			12
15		1		1		2	3	4	3	5		1	2	22
14		2		2	1	1	2	6	4	4	2			24
13	1	2	1		4	1	4	1	1			3		18
12				1	4		6	3	4	3	2			23
11	1				1	1	2	4	2	3		1		15
10			1		2	2		2	1	1	1	2		12
9					1	2		2	1					6
8						1	1	1						3
7				1	2	1	2	1				1		8
6														0
5					1			1		1				3
4														0
3									1					1
Total	2	5	3	6	23	15	25	35	36	27	12	11	2	202

$\sigma x = 2.45$ $\quad r = .19$

$\sigma y = 4.25$ $\quad$ P.E. = .05

$x = .11y$

$y = .33x$

be accompanied by a deviation of .56 times as much in division.

TABLE XXXIII

Correlation was present but low between ability in algebra and multiplication. The correlation was found to be .30 ± .04. It was found that for every unit deviation from the mean in multiplication, it is most probable that there will be an accompahying deviation of .18 as much in ability in algebra and that for every unit deviation from the mean in ability in algebra, it is most probable that there will be an accompanying deviation of .49 as much in multiplication.

TABLE XXXIV

A low correlation was found between ability in algebra and subtraction. The coefficient of correlation was .25 ± .04. A unit deviation from the mean of the scores in subtraction will probably be accompanied by a deviation of .13 as much in ability in algebra. A unit deviation from the mean of the scores in ability in algebra will probably be accompanied by a deviation of .49 as much in subtraction.

Table XXXV

The correlation found between addition and ability in algebra was lower than that found between ability in algebra and any of the other six factors that were compared with it. The coefficient of correlation .19 ±.04 shows that correlation was present but low. From the regression equations it is seen that a unit deviation in addition will probably be accompanied by a deviation of .11 as much in ability in algebra. Also a unit deviation ability in algebra will probably be accompanied by a deviation of .33 as much in addition.

Table XXXVI

This study revealed that a relationship present but low existed between ability in algebra and reasoning ability. The coefficient of correlation was .27 ± .04. A unit deviation from the mean of the scores in reasoning ability will probably be accompanied by a deviation of .26 as much in ability in algebra. A unit deviation from the mean of the scores in algebra ability will probably be accompanied by a deviation of .28 as much in reasoning ability.

TABLE XXVII

CORRELATION OF THORNDIKE-McCALL

READING AGES WITH HOTZ TOTAL SCORES.

R.A.	Hotz Scores -8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	Total
235							1	1		1		1		4
230														0
225					1		2	2	3	3	2	2		15
220														0
215				1	2		3	3	9	5	1	2		26
210														0
205														0
200					5	1	3	15	8	9	1	2	1	43
195														0
190		1			2	4	7	4	6	7	4	2	1	38
185														0
180					3	2	2	3	4	2	3	2		20
175		1		1	4	2	4	3	5	2	1			23
170														0
165		1	3		2	4	1	4						15
160	1			1	1	2	1			1				7
155	1				2		1		1					5
150		1		1	1									3
145														0
140		1		2										3
Total	2	5	3	23	15	25	35	36	27	12	11	2		202

σx = 2.45 r = .50

σy = 20.85 P. E. = 04

x = .29 y

y = .85 x

TABLE XXVIII

CORRELATION OF MENTAL AGES WITH

HOTZ TOTAL SCORES.

Hotz Scores

M.A.	-8	-7	-6	-5	-4	-3	-2	-1	-0	1	2	3	4	Total
230					1		1	1	2			2		7
220						1	1	5	7	4	3	2		23
210		1			5		6	3	7	5	2	2		31
200		1	1		4	4	5	7	5	7	1	2	2	39
190	1			2	4	4	3	7	7	7	3	1		39
180	1				2	3	4	1	3	2	2			18
170					1		1	5	2	2		1		12
160		1		3	4	2	3	5	1		1	1		21
150			2		1	1		1	2					7
140					1		1							2
130		1												1
120		1		1										2
Total	2	5	3	6	23	15	25	35	36	27	12	11	2	202

$\sigma x = 2.45$ $r = .33$
$\sigma y = 22.54$ P. E. = .04

$x = .38\ y$
$y = .32\ x$

Table XXVII

There was a marked relationship found between reading age and ability in algebra. The factor of reading age was found to have the highest relationship with ability in algebra of any of the seven factors that were compared with it. The coefficient of correlation was .50 ±.04.

This marked correlation was found interesting since no studies have seemed to consider reading ability a factor of success in algebra.

The regression equations dosclosed that a unit deviation in reading ability will probably be accompanied by a deviation of .29 as much in ability in algebra. Also, a unit deviation in ability in algebra will probably be accompanied by a deviation of .85 as much in reading ability.

Table XXXVIII.

For these pupils, the data disclosed a relationship present but low. The correlation was .33 ±.04. It was expected to find a correlation much higher than this.

From the regression equations it is seen that a unit deviation in mental age will probably be accompanied by a deviation of .38 as much in ability in algebra. Also, a unit deviation in ability in algebra will probably be accompanied by a deviation of .32 as much in mental age.

TABLE XXXVI

CORRELATION OF STEVENSON PROBLEM

ANALYSIS WITH HOTZ TOTAL SCORES.

Stevenson Score	Hotz Score: -8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	Total
24		2		1	3	4	5	11	10	10	6	4	1	57
23	1		2		2		8	6	7	2		3		31
22		1		1	4	3	3	8	3	6	3	2	1	35
21		1		3	3	1	3	7	12	5	2	1		38
20					3		2	2	1	1	1			10
19						2		1	2	2		1		9
18					2	5	2							9
17					3					1				4
16					1									1
15		1	1	1	1		2							6
14														0
13									1					1
12					1									1
Total	1	5	3	6	23	15	25	35	36	27	12	11	2	202

$\sigma x = 2.45$ $\quad r = .27$

$\sigma y = .2.57$ $\quad$ P.E.= .04

$x = .26\ y$

$y = .28\ x$

Breed and Breslich [1] found a much higher correlation between intelligence composite and Hotz examples. It was .56 ± .06. This can probably be explained by the fact that they gave selected problems from the Hotz tests.

Monroe [2] found a correlation of .37 ± .10 between Otis scores and Rogers Algebraic Computation.

All of the correlations found were positive. This seems to show that all of the factors studied are related. Especially does it seem that the factors compared with achievement in algebra may have enough relationship with it to be causal factors.

1. Page 8 of this Thesis.
2. Page 10 of this Thesis.

CHAPTER V

THE INTERPRETATION OF FINDINGS. CONTINUED.

B. PARTIAL RELATIONSHIPS

It was one of the objects of this study to show to what extent the factors of intelligence, reading ability, arithmetic reasoning ability, and ability in computation predict success in algebra. There was also a desire to study further the relationship of reading age and achievement in algebra.

The method used in this part of the investigation was partial correlation. McCall's formula

$$r_{12.345678} = \frac{r_{12.34568} - (r_{13.45678})\, r_{23.45678})}{\sqrt{1 - (r_{13.45678})^2}\ \sqrt{1 - (r_{23.45678})^2}}$$

was used. Each of the seven factors was compared by partial correlation with achievement in algebra, all of the others being held constant. In this way it was hoped to point out which factor had the most influence on success in algebra. By this method the writer also wished to show whether or not reading age did have as close a relationship with achievement in algebra as the original correlations seemed to indicate.

TABLE XXXIX

COEFFICIENTS OF CORRELATION AND PROBABLE ERRORS

USED IN THIS STUDY.

	Hotz Total	Mental Age	Reading Age	Stevenson Reasoning	Addition	Sub-traction	Multi-plication	Division
Hotz Total		.35±.04	.50±.04	.27 ±.04	.19 ±.04	.25±.05	.30±.04	.29 ±.04
Mental Age	.33±.04		.53±.03	.27 ±.04	.17±.05	.22±.05	.21±.05	.25±.04
Reading Age	.50±.04	.52±.03		.27 ±.04	.04 ±.05	.14±.05	.12±.05	.13±.05
Stevenson Reasoning	.27±.04	.27±.04	.27±.04		.14 ±.05	.23±.04	.19±05	.24±.04
Addition	.19±.04	.17±.05	.04±.05	.14 ±.05		.64±.03	.70±.02	.68±.02
Sub-traction	.25±.04	.22±.05	.14±.05	.23 ±.04	.64 ±.03		.71±.02	.68±.02
Multipli-cation	.30±.04	.21±.05	.12±.05	.19 ±.05	.70 ±.02	.71±.02		.70±.02
Division	.29±.04	.25±.04	.13±.05	.24 ±.04	.62 ±.03	.68±.02	.70±.02	

TABLE XL

COEFFICIENTS OF PARTIAL CORRELATION

COMPUTED FOR THIS STUDY.

Hotz Algebra Scales and Mental Age without the Other Six Factors	.007
Hotz Algebra Scales and Reading Age without the Other Six Factors	.42
Hotz Algebra Scales and Arithmetic Reasoning without the Other Six Factors	.11
Hotz Algebra Scales and Addition without the Other Six Factors	.103
Hotz Algebra Scales and Subtraction without the Other Six Factors	.005
Hotz Algebra Scales and Multiplication without the Other Six Factors	.14
Hotz Algebra Scales and Division without the Other Six Factors	.18

TABLE XLI

ORIGINAL AND PARTIAL COEFFICIENTS OF CORRELATION BETWEEN ACHIEVEMENT IN ALGEBRA AND SEVEN FACTORS OF SUCCESS.

Factors of Success	Mental Age	Reading Age	Arithmetic Reasoning	Addition	Sub-traction	Multipli-cation	Division
Achievement in Algebra							
Original	.35 ± .04	.50 ± .04	.27 ± .04	.19 ± .04	.25 ± .04	.30 ± .04	.29 ± .04
Partial	.007	.42	.11	-.103	.005	.14	.18

Reading age seemed to have the most influence on achievement in algebra in this investigation. The partial correlation coefficient of .42 was a decrease from the original correlation of .50. This partial coefficient of .42 still shows a marked relationship between these two factors.

The factor of division seemed to have the second most important influence on achievement in algebra. The partial coefficient of .18 shows some relationship although it is slight.

Multiplication seemed to be the next in importance. This partial coefficient was .14, which also shows slight relationship.

Reasoning ability seemed to have suffered quite a reduction from the original correlation. The partial coefficient .11 is still enough

to show that there is some relationship.

The partial coefficient of -.103 shows that there is some inverse relation between addition and achievement in algebra when freed from the influence of the other six factors.

These data disclosed the fact that mental age alone had no influence on achievement in algebra. This result deserves attention because there is a very common belief among teachers that this is the most important factor.

Subtraction also appeared to have no influence when freed from the other factors.

CHAPTER VI

SUMMARY OF FINDINGS

A careful consideration of the data obtained in this study of success factors in first year algebra of pupils in Central Junior High School at Kansas City, Missouri, reveals the following facts:

Three of the tests given: namely, the Courtis Subtraction Test, the Courtis Division Test, and the Stevenson Analysis Test did not seem to measure this group of pupils.

The distribution of reading ages was multimodal.

INTER-RELATIONSHIPS

1. A high correlation was found to exist between Courtis multiplication scores and Courtis division scores.

2. A high correlation was also found between Courtis division scores and Courtis subtraction scores.

3. The relationship between Courtis subtraction scores and Courtis multiplication scores was high.

4. The relationship between Courtis addition scores and Courtis division scores was found to be marked.

5. A high correlation was found to exist between Courtis addition and Courtis multiplication scores.

6. The correlation between Courtis addition and Courtis subtraction scores was marked.

7. The relationship between Courtis division scores and Stevenson Problem Analysis scores was low though significant. This relationship was curvilinear, which further indicates that these tests probably did not measure this group.

8. The relationship found between Courtis multiplication scores and Stevenson Problem Analysis scores was almost negligible. The correlation table shows a non-linear relationship between these two factors.

9. Between Courtis subtraction scores and Stevenson Problem Analysis scores the correlation was low. Here also a skewed curve was found, due to the Stevenson scores.

10. There was very little relationship found between Stevenson Problem Analysis scores and Courtis addition scores. Here also the relationship was non-linear.

11. There was a slight relationship found between Thorndike-McCall Reading Ages and Courtis division scores. The skewed curve found here is probably due both to the nature of the division scores and to the unusual distribution of the reading ages.

12. The relationship between reading ages and multiplication scores was very low. This curvilinear relationship was probably due to the reading age distribution also.

13. Slight relationship was found between reading ages and subtraction scores. Another curvilinear relationship was found here.

14. No correlation was found to exist between reading ages and addition scores. This was also a non-linear relationship.

15. Correlation was found to be present but low between reading ages and reasoning scores. This relationship was also curvilinear.

16. The correlation between mental ages and division was low. A skewed curve was found here also.

17. There was found a low correlation between mental ages and multiplication scores.

18. The correlation found between mental ages and subtraction scores was low.

19. A slight relationship was found between mental ages and addition scores.

20. A low though significant relationship was found between reading ages and reasoning scores. A curvilinear relationship found here which was probably due to the nature of these two sets of scores.

21. There was a marked relationship between mental ages and reading ages. The curve in this correlation was also non-linear.

22. A positive low correlation was found to exist between achievement in algebra and division. This relationship was curvilinear.

23. A present but low relationship was found to exist between achievement in algebra and multiplication.

24. A low correlation was found between achievement in algebra and subtraction. This relationship was non-linear.

25. A very low correlation was found to exist between achievement in algebra and addition.

26. There was found a low positive correlation between achievement in algebra and reasoning ability. This relationship was curvilinear.

27. There was a marked relationship found between achievement in algebra and reading ages. The skewed curve found here was probably due to the unusual distribution of the reading ages.

28. The correlation between achievement in algebra and mental ages was present but low.

PARTIAL RELATIONSHIPS

Reading age had a marked influence on achievement in algebra when freed from the other six factors considered.

Arithmetic reasoning, multiplication, and division each when taken alone seemed to have slight influence on achievement in algebra.

Addition was found to have a slight negative influence on achievement in algebra.

Neither mental age nor subtraction when taken alone seemed to have any influence on achievement in algebra.

CHAPTER VII

APPLICATION OF FINDINGS

It seems safe, in the light of the data studied, to conclude that these seven factors considered do help to determine a pupil's success in algebra. However, success in algebra does not depend on these factors alone, for it is realized that all of the factors of success have not been included in this investigation.

The unusual results found in the study may be due to the fact that too small a number of pupils was included to make the results reliable. The investigation was also limited to one school. However, the results do offer some very helpful suggestions.

It seems that it would be valuable to have on record the scores on each of these seven measures for every pupil entering the second year of junior high school. These records would be helpful for two purposes: first, for use in classification and second, for aid in advising pupils as to whether or not they should enroll in algebra.

For instance, suppose a child was enrolling whose ability in division was two units above the mean in division. From the regression equation it would be found that he would probably be

.30 of a unit above the mean in ability in algebra. The same could be done for each of the other six factors. Then the average of these would give a fair estimate, other things being equal, of what success this pupil would make in algebra.

The use of all of these scores as a basis for classification would certainly give better results than the use of the intelligence score alone.

When measures are found for the other factors which seem to be factors of success in algebra, this study can be greatly extended.

APPENDIX

Pupil	M.A.	R. A.	Stev.	Add.	Sub.	Mul.	Div.	Hotz.
1	189	192	24	14	14	10	14	2.24
2	201	203	20	21	20	17	23	.12
3	191	158	23	11	11	11	14	-7.92
4	194	203	24	18	23	17	24	-.27
5	193	181	24	14	19	13	21	-.56
6	228	203	23	9	13	9	10	-.15
7	186	175	22	14	17	11	8	-1.40
8	207	169	18	19	22	14	22	-2.05
9	163	192	24	15	17	17	13	3.89
10	234	218	22	13	18	11	13	3.40
11	195	203	24	18	17	14	16	-.62
12	170	203	22	12	14	16	16	-.52
13	164	192	24	10	12	10	11	-.64
14	202	175	20	13	9	9	16	-3.05
15	205	203	24	7	7	7	8	-.62
16	214	226	17	13	13	5	10	-3.90
17	158	169	23	13	17	15	19	-5.20
18	169	164	22	16	19	11	23	-4.69
19	188	158	20	15	20	16	23	-1.88
20	186	175	21	11	13	12	22	1.78
21	186	175	21	17	18	17	18	.37
22	198	203	21	19	18	16	19	-.89
23	204	203	24	14	15	9	20	1.93
24	228	192	19	18	24	15	20	1.87
25	210	181	21	17	21	16	23	.38
26	157	158	21	23	11	13	13	.49
27	204	192	16	9	12	10	16	-3.51
28	171	203	22	16	12	12	11	-3.25
29	215	203	23	19	24	18	24	-1.55
30	137	152	15	15	12	6	11	-6.20
31	181	164	19	13	20	7	21	-7.44
32	166	141	24	14	19	13	19	-4.27
33	205	181	18	7	8	7	5	-2.94
34	195	192	18	12	23	18	24	-1.90
35	199	169	22	22	23	14	23	-2.45
36	191	226	24	12	16	15	23	.18
37	234	226	24	9	19	10	18	-.29
38	194	181	20	11	9	7	11	1.85
39	173	218	23	18	18	18	20	1.97
40	208	203	24	12	14	13	11	-1.53
41	160	169	22	13	15	12	11	-6.55

	M.A.	R.A.	Stev.	Add.	Sub.	Mul.	Div.	Hotz
42	126	141	15	7	15	8	18	4.55
43	162	181	12	20	9	13	11	3.87
44	218	226	20	12	12	7	11	1.77
45	198	218	21	15	18	13	13	1.69
46	154	203	23	16	18	14	18	.72
47	205	203	24	15	14	11	15	1.11
48	168	192	21	13	13	13	17	1.44
49	175	175	24	12	16	12	19	.18
50	148	152	18	5	10	8	13	3.65
51	187	192	21	11	11	9	11	.90
52	232	192	23	15	23	15	13	1.72
53	197	192	22	10	14	5	12	2.93
54	226	226	21	12	17	10	18	1.58
55	187	175	17	7	10	6	8	3.64
56	192	175	21	17	24	18	16	.98
57	203	169	23	11	18	8	11	.04
58	156	192	21	9	14	10	17	2.18
59	197	192	24	12	7	5	12	3.41
60	166	175	21	14	20	15	18	.01
61	196	203	24	9	10	10	13	2.37
62	174	203	22	14	12	9	13	.79
63	203	203	24	23	21	15	23	1.35
64	199	192	22	15	19	10	19	1.85
65	159	181	20	12	18	9	9	.68
66	169	175	23	15	16	14	16	1.22
67	220	192	21	17	19	20	24	.63
68	206	226	23	14	21	18	18	.40
69	214	181	21	16	17	18	24	.62
70	204	203	24	17	19	14	21	.75
71	212	203	24	15	17	12	10	.11
72	215	203	24	14	14	12	18	1.50
73	212	218	24	20	23	19	24	1.37
74	188	203	17	17	14	13	14	1.37
75	197	235	24	11	9	11	18	1.34
76	169	169	22	11	11	13	9	.41
77	215	203	22	17	13	16	21	1.87
78	197	226	19	14	13	12	17	1.74
79	172	203	21	14	17	9	15	.13
80	234	226	24	21	23	13	24	.49
81	196	203	22	19	21	16	21	.37
82	187	235	23	5	10	5	8	.06

	M.A.	R.A.	Stev.	Add.	Sub.	Mul.	Div.	Hotz
84	197	203	22	11	13	10	15	.27
85	196	203	20	21	20	15	15	156
86	151	169	5	10	17	10	13	5.03
87	226	218	24	13	16	14	24	.58
88	200	164	22	13	15	14	17	3.32
89	217	218	24	17	20	19	23	1.85
90	201	192	24	16	19	13	20	2.02
91	215	192	23	16	18	16	18	.14
92	225	203	24	15	22	14	23	.06
93	234	203	20	10	9	5	8	3.30
94	207	181	24	24	21	17	24	.33
95	215	218	24	11	10	7	13	3.17
96	166	169	21	11	11	7	9	.25
97	216	218	21	14	19	15	19	195
98	187	175	17	13	16	13	21	3.92
99	200	192	22	15	17	17	20	.59
100	186	175	24	17	16	10	19	2.52
101	147	175	22	12	10	12	12	1.53
102	194	203	23	20	24	18	20	.48
103	215	218	20	12	11	6	11	3.30
104	219	203	21	11	13	13	14	.67
105	201	158	22	17	18	18	22	3.54
106	175	181	23	7	13	5	12	1.53
107	203	192	21	15	19	16	13	1.99
108	206	218	24	24	24	18	24	.65
109	195	158	22	16	17	12	13	3.65
110	217	192	24	14	19	14	13	6.55
111	226	218	21	13	16	12	16	.74
112	196	181	21	15	17	18	19	.22
113	204	192	24	16	21	16	17	1.87
114	204	192	24	16	21	16	17	1.87
115	221	226	23	15	22	15	16	.98
116	205	164	19	8	9	8	13	2.73
117	211	218	21	16	11	8	16	1.53
118	125	141	24	13	16	7	15	6.47
119	210	218	19	23	22	23	21	.57
120	162	203	24	19	22	15	18	3.80
121	205	192	24	13	13	11	20	3.34
122	222	181	24	14	14	8	15	2.76
123	206	203	23	13	24	15	21	1.55
124	205	192	22	15	10	7	11	2.78
125	2000	175	21	14	7	10	16	6.07

	M.A	R.A.	Stev.	Add.	Sub.	Mul.	Div.	Hotz
126	203	181	21	13	12	10	18	3.01
127	212	203	19	10	10	5	10	3.90
128	213	203	23	7	7	7	7	3.65
129	165	192	18	8	13	8	15	1.28
130	190	218	24	12	12	10	10	2.63
131	168	192	20	10	10	12	14	2.63
132	170	192	22	14	11	10	8	0
133	202	169	24	14	13	10	20	.52
134	185	175	21	11	13	9	15	1.38
135	189	169	24	13	8	5	8	2.27
136	191	175	13	14	11	8	14	.08
137	163	169	19	15	17	14	14	2.15
138	223	226	24	23	22	24	23	2.62
139	202	203	24	15	22	10	18	1.19
140	178	203	24	10	8	10	16	3.01
141	191	203	22	18	22	16	21	.25
142	195	192	22	12	19	13	14	1.74
143	153	181	18	10	4	3	8	3.07
144	190	203	21	12	14	8	11	3.69
145	196	175	21	20	11	18	16	3.04
146	196	175	18	16	18	14	15	2.41
147	213	218	24	7	12	9	8	1.14
148	228	192	24	22	21	19	24	.18
149	171	175	21	14	17	16	22	1.37
150	186	181	24	22	24	20	23	2.90
151	192	218	22	10	16	11	18	1.85
152	187	181	21	12	14	8	16	.35
153	221	226	24	24	24	17	24	2.75
154	172	192	21	10	13	14	15	.56
155	222	203	22	17	22	14	22	2.37
156	222	192	3	5	9	7	9	1.00
157	166	192	15	20	21	17	23	1.60
158	214	192	23	19	21	17	16	1.24
159	192	175	21	15	13	14	13	4.27
160	181	192	18	10	10	12	16	2.19
161	216	181	22	17	15	11	20	2.84
162	210	169	15	12	8	9	6	3.45
163	217	218	24	14	17	9	21	.61
164	196	175	21	14	13	11	20	2.28
165	163	152	21	12	18	9	18	4.58
166	234	235	23	22	24	17	22	3.02

	M.A	R.A	Stev.	Add.	Sub.	Mul.	Div.	Hotz
167	224	181	23	12	10	11	16	1.49
168	193	218	22	11	24	14	13	3.73
169	210	226	23	20	20	13	24	3.02
170	188	226	22	13	19	8	15	1.67
171	223	203	23	12	16	15	15	106
172	210	192	22	22	18	18	24	2.13
173	221	203	19	17	23	13	17	.72
174	206	192	24	22	21	18	22	1.14
175	209	169	23	14	16	10	21	1.46
176	232	218	24	20	20	16	23	.98
177	192	175	15	12	10	6	9	1.79
178	190	181	21	12	5	9	9	2.62
179	224	203	22	8	10	11	13	.79
180	206	218	24	20	21	16	19	.36
181	228	181	24	21	22	20	23	3.80
182	214	235	22	11	17	8	19	1.74
183	211	192	19	23	22	23	23	.93
184	166	169	23	17	12	12	13	3.28
185	209	164	23	13	13	11	12	1.24
186	220	218	23	11	20	16	24	.88
187	223	226	24	17	19	16	18	1.37
188	221	226	23	7	9	7	15	3.01
189	201	218	21	3	6	9	11	.41
190	206	192	22	15	23	13	23	4.01
191	172	175	22	15	14	14	12	199
192	212	218	24	15	19	17	19	1.03
193	201	203	24	15	23	15	22	4.28
194	191	203	24	10	12	5	14	.60
195	203	192	24	12	14	14	21	1.74
196	221	192	23	17	24	14	22	.72
197	169	175	22	18	22	16	21	.93
198	215	218	23	9	8	9	12	.76
199	200	169	23	19	22	12	24	5.72
200	191	164	22	16	21	16	22	1.13
201	192	218	21	14	13	9	10	4.51
202	163	164	18	11	12	6	12	2.39
203	166	181	21	14	13	11	16	3.19
204	200	218	21	16	15	15	19	.54

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